LUMASENSE™ TECHNOLOGIES

LumaSense UV Pyrometry

True Wafer Surface Temperature and Reflectance Instrumentation for GaN-based Epitaxy

UV 400 • UVR 400

- **Improve Yield** through accurate true wafer temperature measurement
- **Measure Temperature Directly** on the GaN layer using UV wavelength instrumentation
- **Obtain Reliable Wafer Temperature** with PL wavelength correlation
- **Capture Real Time Reflectance Measurement** using a fast pulsing light source
- **Prevent Residue Temperature Oscillation** as seen in NIR emissivity-compensated pyrometers
- **Prevent Data Skew** due to delayed sampling (no shutter on and off)
- **Minimize Noise** in measurement using true photo-counting instrumentation

The LumaSense UV 400 and UVR 400 systems are the next generation of temperature sensors developed specifically for GaN-based MOCVD epitaxy processes. These pyrometers allow direct measurement of the wafer surface temperature instead of the traditional susceptor/pocket temperature.

This improved measurement allows more accurate control of the wafer temperature leading to an improved yield. These systems are setting a new standard for LED production processes with results showing reliable correlation between process temperature and final product wavelength.

The UVR 400 includes an additional reflectometer at 635 nm with 0.5 kHz measurement speed. This enables measurement of deposition thickness.

LumaSense Technologies is a world leader in sensing solutions, with over 30 years of temperature sensing expertise in the Semiconductor and Compound Semi industries.

LumaSense pioneered the first pyrometer with integrated reflectometer (TR 100) in 2001, establishing the industry standard for active emissivity compensation using 950 nm and fiber optics**.** Our advances in sapphire light-pipe sensors and in-situ blackbody calibration sources provide a complete temperature measurement solution. LumaSense Technologies has shipped over 8000 instruments into the semiconductor market and has an installation base of over 2000 instruments in the MOCVD application.

Technical Data

Measurement Specifications

Temperature Range:	650 to 1300 °C
Sub Range:	Any range adjustable within the temperature range, minimum span 51 °C
Spectral Range:	383 to 410 nm (10% of values)
Detector:	Photomultiplier, dark count range < 1% of the raw value at 650 °C
Latency time between 2 measurements	< 1 µs
Resolution:	0.1 °C at interface; < 0.025% of the set partial measurement range at the analog output (12 bits)
Emissivity ε:	0.100 to 1.000 in steps of 1/1000
Transmittance τ:	0.100 to 1.000 in steps of 1/1000
T Integration Time:	Min of 8 ms
Measurement Uncertainty: (ε = 1, t_{90} = 1 S, $T_{hous.}$ = 28 °C)	Up to 1000 °C: 3 °C Above 1000 °C: 0.3% of the measurement value in °C (Note: the pyrometer must be in operation for 30 minutes before these values are valid).
Repeatability: (ε = 1, t_{90} = 1 S, $T_{hous.}$ = 28 °C)	0.1% of the measurement value in °C + 0.1 °C

Environmental Specifications

Protection Type:	IP 40 IEC 60529
Vacuum and gas conditions:	Device withstands an atmosphere of nitrogen and a vacuum (< 10 mbar). Housing has air opening
Installation Position:	any
Operating Temperature:	10 to 38 °C on the housing
Storage Temperature:	-20 to +50 °C
Relative Humidity:	Non condensating conditions
Weight:	2.5 kg (instrument without adapter)
Housing:	Black anodized aluminum
CE Label:	According to EU directives about electromagnetic immunity

Interface

Connections:	M12 (8-pin) plug connector for the power supply, RS485 and analog output of the measurement temperature M12 (4-pin) plug connector for the analog output of reflectance measurement
Parameters:	Adjustable via interface: Emissivity ε, Transmittance τ, setting time t_{90}, delete time t_{cl}, 0 to 20 or 4 to 20 mA analog output (switchable), sub range RS485: address, baud rate, wait time t_W Readable via interface: Internal detector temperature in 0.1°C

Communication

Analog Output:	0 to 20 mA or 4 to 20 mA, linear (via digital interface)
Digital Interface:	RS485 addressable (semi-duplex) Baud rate: 1200 to 38400
Maximum Value Storage:	Built-in single or double storage. Clearing with adjusted time t_{clear} (off; 0.01 s; 0.05 s; 0.25 s; 1 s; 5 s; 25 s) via interface

Electrical

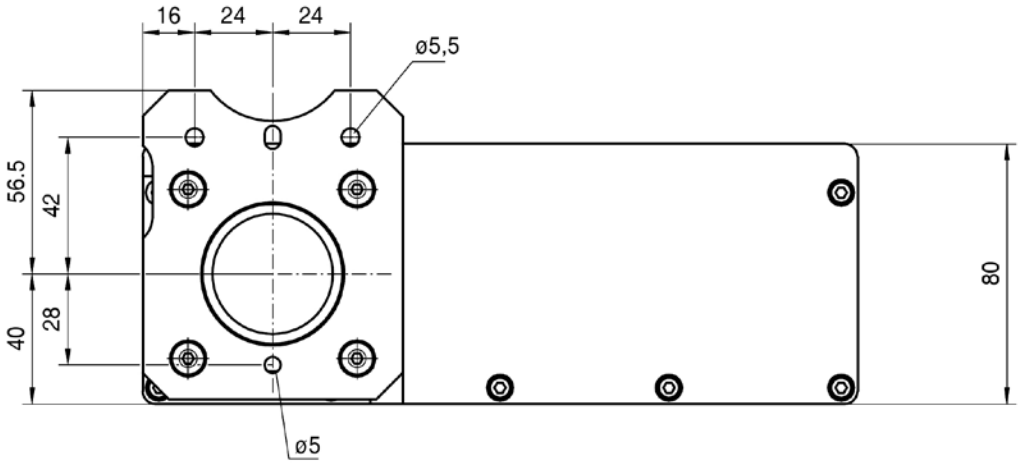
Power Consumption:	Max. 5 W
Load (analog output):	0 to 500 Ω
Isolation:	Power supply, analog output and digital interface are electrically isolated from each other

Reflectance Measurement (UVR 400 only)

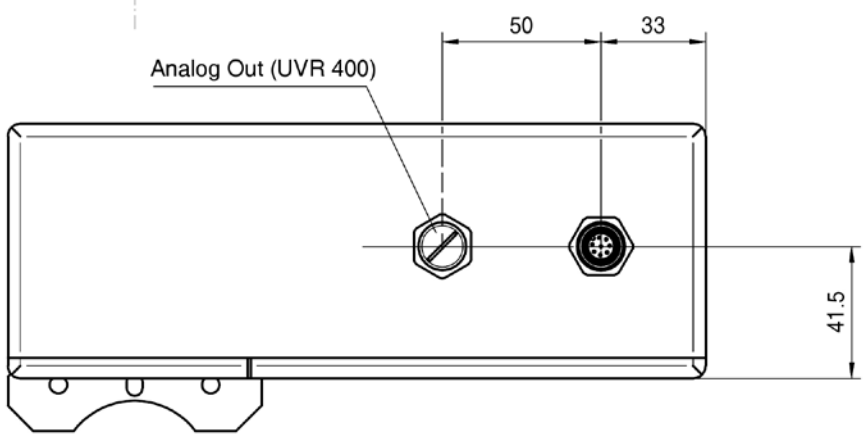
Measuring range:	0 … 100%
Speed:	1000 Hz
Light source:	Laser diode
Detection wavelength:	635 nm ± 5 nm
Measurement Uncertainty: ($T_{hous.}$ = 25 °C)	2% of range
Repeatability: ($T_{hous.}$ = 25 °C)	0.5% of range
Acceptable tilt tolerance of wafer:	0.3°
Optical working distance a:	100 mm
Analog output:	0 to 20 mA or 4 to 20 mA (linear); switchable
Load:	0 to 500 Ohm

Product Schematic

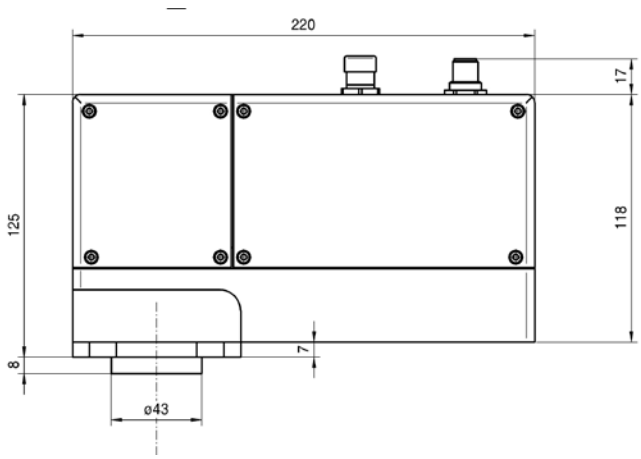
Bottom View



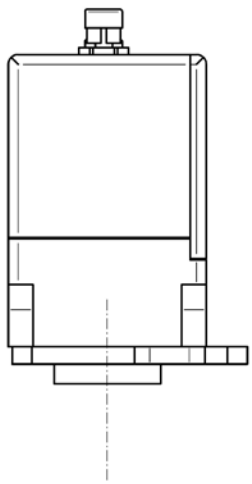
Top View



Side View



Profile View



Dimensions in mm

Optics

The pyrometer is equipped with the optics listed below. The optics are focused for a specific distance, which means that at that distance the optics have their smallest possible spot size in relation to the measuring distance. If the distance from the object being measured is increased or decreased, the spot size changes.

The table below shows examples of distances and the corresponding spot diameters:

Aperture *D*/mm	Quartz window thickness = 10 mm	Measuring Distance a/mm	Spot size M/mm
37 (G5)	with	74	9.8
37 (G5)	without	77	10.2
37 (G4)	with	80	10.0

Reference Numbers

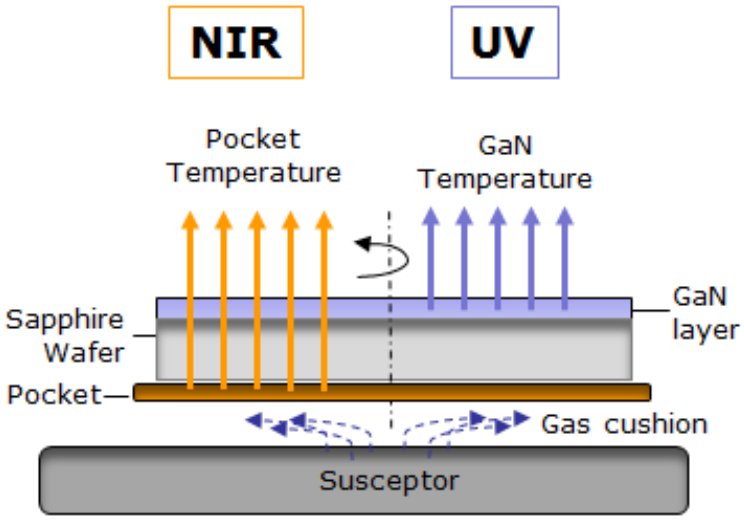
Instruments - MB 13 - (650 °C to 1300 °C)

3 905 200	UV 400 Pyrometer – G5	3 905 210	UVR 400 Pyrometer – G5
3 905 220	UV 400 Pyrometer – G4	3 905 230	UVR 400 Pyrometer – G4
3 905 240	UV 400 Pyrometer – custom	3 905 250	UVR 400 Pyrometer – custom

Measurement of the GaN Layer

GaN material emits below 400 nm in the ultraviloet spectrum and improvements in short wavelength detectors
allow for measurement of the epitaxial layer temperatures.

Unlike NIR measurement, UV measurement only measures the GaN layer. Near 400 nm, a relatively thin GaN layer becomes opaque and the pyrometer does not see through the wafer. This results in a direct measurement of the wafer surface!



LumaSense Technologies **Awakening Your 6th Sense**

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